REMARKS

The present application stands with pending claims 1-39, where claims 1, 16, 29, 33 and 36 are independent.

As a preliminary matter, Applicant appreciates the Examiner's acknowledgment of allowable subject matter in claims 4-15, 30 and 38, and that claims 16-28 and 39 are allowed.

Claims 1-3, 36 and 37 stand rejected under 35 U.S.C. §103 as being unpatentable over Goepel et al. (U.S. 5,182,578) in view of Mitani et al. (U.S. 5,666,140). In response, Applicant respectfully traverses, first, because the cited references, alone or in combination, do not provide motivation to derive the presently claimed invention as recited in claim 1. Both Goepel and Mitani disclose thermal impulse print heads that heat the ink quickly to produce a vapor bubble that ejects an ink droplet. No concern for constant temperature is involved with the cited references.

In contrast, the present invention is related to piezoelectric print heads that automatically maintain ink at a constant temperature for improving printing performance. The invention of claim 1 involves a planar heater of thermistor material that is placed at a certain orientation relative to the ink flow paths in the print head. As the cited references do not address the problem of maintaining ink at a constant temperature in a print head, nothing in the cited references can provide the motivation that leads to the solution as recited in claim 1. For this reason, Applicant submits that the §103 rejection of claims 1 and its depending claims 2-3 has been overcome and respectfully requests that the rejection be withdrawn.

In addition, Applicant traverses because the cited references do not disclose or suggest the claimed "ink heater made of a thermistor material" as recited in claim 1. Instead, Goepel discloses a PTC resistor as a sensor (7), not as an ink heater (see, e.g., Col. 3, lines 40-41). In addition, Fig. 1 shows a separate heater (6) that is merely a voltage regulator (col. 3, lines 32-33), and is not made of thermistor material.

Further, the Examiner understands that Goepel does not disclose or suggest "the ink heater having a substantially planar configuration and extending in a plane generally parallel to the plane of the ink channels" as recited in claim 1. The Examiner uses Mitani to derive this feature.

Mitani, however, does not disclose or suggest the claimed heater either. Claim 1 recites an ink heater extending in a plane "adjacent to the ink channels." Instead, the thermal resistor (16) of Mitani is located in the ink chamber (13) (see, e.g., Col. 5, lines 33-37 and FIG. 2). By any reasonable reading, it is impossible for the thermal resistor (16) of Mitani to be "adjacent" a channel when it is shown instead to be "in" the channel. This difference also highlights the fact that the present invention preferably uses one heater to maintain constant temperature for a number of ink channels, and is therefore positioned outside of the ink channels, while in contrast, Mitani discloses a thermal resistor (16) to create separate impulses to move the ink in each ink chamber (13).

Also, Mitani does not disclose or suggest an ink heater "extending in a plane generally parallel to the plane of the ink *channels*." Figures 2 and 3 of Mitani only show a single ink chamber 13 and ink channel 11. It is not possible to determine the direction of the plane of a plurality of ink channels from these figures. Without some clear indication of the

direction of a plane of the ink channels, the presently claimed invention, as recited in claim 1, cannot be derived without the improper use of hindsight.

Finally, Mitani does not reasonably and fairly disclose or suggest an ink heater with "a substantially planar configuration." Nothing is expressly disclosed about the shape of the thermal resistor 16 from the drawings in Mitani even though the location of resistor 16 is indicated on Figures 2 and 3 of Mitani. Without any clear visible disclosure of the thermal resistor 16 in the drawings of Mitani, Mitani cannot be held to disclose the shape of an ink heater as recited in claim 1.

Since neither of the cited references disclose or suggest the claimed ink heater for the reasons indicated above, Applicant submits that the §103 rejection has been overcome and respectfully requests that the rejection of claim 1 and its depending claims 2-3 be withdrawn.

In response to the rejection of claim 36, first, Applicant repeats the arguments used above to overcome the rejection of claim 1. Specifically, Applicant asserts that neither of the cited references, Goepel nor Mitani, teaches or suggests the claimed step of "using a planar ink heater generally parallel" to the common plane of the ink channels. For this reason alone, Applicant respectfully requests that the rejection of claim 36 be withdrawn.

Second, claim 36 recites a method for "maintaining the ink in an ink jet print head at a uniform temperature." As already explained above, this is neither an objective of, nor a result achieved by, Goepel or Mitani. Instead, as both Goepel and Mitani concern thermal impulse print heads, these references disclose quickly heating the ink to produce a vapor bubble that ejects an ink droplet. Clearly, in such an operation, the ink is not maintained at a

uniform temperature. For this reason alone, Applicant respectfully submits that the §103 rejection of claim 36 and its depending claim 37 has been overcome and respectfully requests that the rejection be withdrawn.

Claims 29 and 31-35 stand rejected under 35 U.S.C. §103 as being unpatentable over Goepel et al. (U.S. 5,182,578) in view of Takahashi (JP407025011A). In response, Applicant respectfully traverses because the cited references do not disclose or suggest a "planar member made of thermistor material having a positive temperature coefficient." As stated previously, the PTC sensor (6) in Goepel is not a heater. The heater (7) merely discloses a voltage regulator in Goepel that is not made of thermistor material.

It appears that the Examiner is only using Takahashi to derive first and second electrodes extending on one side of the planar member as recited in claim 29. In response, claim 29 does not just recite a "planar member" but one that is made of "thermistor material having a positive temperature coefficient" to be used as a heater.

A thermistor material PTC planar member (or heater) is not recited at all in Takahashi. To conclude that using electrodes on one electrical component suggests using electrodes on another electrical component just because it has a similar shape is entirely the improper use of hindsight to derive the present invention. Some specific motivation for using the claimed electrodes with a heater must be present. Otherwise, it is impossible to have any form of reasonable expectation of success as required for a prima facie obviousness rejection.

In contrast to heating, Takahashi merely discloses that PTC material itself is used as electrodes (9), and is not used for heating ink in an ink jet print head as recited in Claim 29.

Further, it appears that the PTC electrodes (9) of Takahashi are used to activate the PZT layer (6) so as to eject the ink in a "shear mode" type of fashion (*See, e.g.*, Takahashi Figs. 2 and 3, pp. 9-10). Thus, Takahashi uses PTC materials for a completely different purpose than the heating purpose of the present invention. Accordingly, the combination of Goepel and Takahashi does not teach or disclose the claimed thermistor.

Furthermore, the Examiner relies on Takahashi for the teaching that electrodes are included on the planar member "for the purpose of alternating the use as a conductor or insulator depending on the temperature levels as noted in the last three lines of the Abstract." In Takahashi, however, as the electrodes are formed of a PCT material, Takashi discloses alternating the use of the electrodes as either a conductor or an insulator.

In contrast, in the present invention, it is the thermistor/ink heater that is made of the PCT material, not the electrodes, and the placement of the electrodes can thermally tune the ink heater. The electrodes are NOT alternating between use as a conductor or insulator. In the present invention, the electrodes may be strategically positioned and shaped on the thermistor heater so as to balance the heat dissipation variations in the ink channels of the print head. Since Takhashi cannot provide the motivation to derive the electrodes as recited in claim 29, Applicant respectfully requests that the §103 rejection of claims 29 and its depending claims 31-35 be withdrawn.

Applicant further separately traverses regarding claims 31-34 and asserts the following:

Goepel and Takahashi, alone or in combination, do not disclose or suggest using electrodes to thermally tune a thermistor, such as by forming the electrodes in a pattern as

recited in claims 31 and 32. For that matter, the cited references make absolutely no mention of the concept of thermal tuning.

Goepel and Takahashi, alone or in combination, do not disclose or suggest "thermally tuning an ink heater," as recited in claim 33 and which is one of the objectives of the claimed method.

Goepel and Takahashi, alone or in combination, do not disclose or suggest "forming the ink heater using a thermistor material" as recited in claim 33. Instead, and as stated previously, Goepel discloses a PTC resistor as a sensor (7), not as an ink heater (see, e.g., Col. 3, lines 40-41). Fig. 1 clearly shows a separate heater (6). Takahashi has no teaching or disclosure in the provided translation of Takahashi of an ink heater.

Goepel and Takahashi, alone or in combination, do not disclose or suggest "attaching a plurality of electrodes" to an ink heater made of thermistor material as recited in claim 33.

Goepel and Takahashi, alone or in combination, do not disclose or suggest attaching the electrodes in a pattern based on the heat dissipation of the ink jet print head as recited in claim 34.

For all of these additional reasons, Applicant respectfully requests that the §103 rejection of claims 31-35 be withdrawn.

For all of the above reasons, Applicants request reconsideration and allowance of all of the pending claims. The Examiner should contact the undersigned attorney if an interview would expedite prosecution.

Respectfully submitted,

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The Current Version of the Claims:

1. (Original) An ink jet print head, comprising:

a plurality of ink channels disposed in a common plane, each of said channels having at least one orifice for projecting ink towards a substrate; and

an ink heater made of a thermistor material, the ink heater having a substantially planar configuration and extending in a plane generally parallel to the plane of the ink channels and adjacent to the ink channels.

2. (Original) The print head of claim 1, wherein the ink heater is made of a thermistor material having a positive temperature coefficient.

3. (Original) The print head of claim 1, wherein the ink heater is made of a ceramic thermistor material.

4. (Previously amended) The print head of claim 2, wherein the thermistor material includes a first side and a second side, and the ink heater includes a first electrode and a second electrode located on the first side of the thermistor material, wherein heat is generated on the first side of the thermistor material between the first and second electrodes.

5. (Original) The print head of claim 4, further comprising a first lead electrically coupled to the first electrode, and a second lead electrically coupled to the second electrode.

6. (Previously amended) The print head of claim 4, wherein the ink heater include a first edge and a second edge, the first edge is located opposite from the second edge, the first and second edges extend in a direction which is substantially perpendicular to the plurality of ink channels, the first electrode extends along the first edge and the second electrode extends along the second edge, wherein the first and second electrodes are opposite from one another and substantially parallel.

7. (Previously amended) The print head of claim 6, wherein the first electrode extends near a center portion of the thermistor material, and the second electrode extends near the center portion of the thermistor material, wherein the first and second electrodes are in close proximity to one another so as to minimize the time the ink heater reaches equilibrium.

8. (Original) The print head of claim 4, wherein the plurality of ink channels include one or more channels which dissipate heat at a higher rate than other channels, and the first and second electrodes are located in an arrangement so that the thermistor material generates greater heat in a first area located adjacent the one or more channels than a second area adjacent the other channels.

9. (Previously amended) The print head of claim 8, wherein the plurality of ink channels include outside channels and inside channels, and the first and second electrodes include a first end and a second end and a mid-portion, wherein the first and second ends are

wider than the mid-portion, wherein greater heat is generated adjacent the outside channels than adjacent the inside channels.

10. (Previously amended) The print head of claim 8, wherein the plurality of ink channels include outside channels and inside channels, the first and second electrodes include a first end and a second end and a mid-portion, wherein the first and second ends are narrower than the mid-portion, wherein greater heat is generated adjacent the inside channels than adjacent the outside channels.

11. (Previously amended) The print head of claim 4, wherein the ink heater includes a first longitudinal edge, a second longitudinal edge, a first transverse edge and a second transverse edge, the first longitudinal edge is located opposite from the second longitudinal edge, the first and second longitudinal edges extend in a direction which is substantially perpendicular to the plurality of ink channels, the first transverse edge is located opposite from the second transverse edge, the first and second transverse edges extend in a direction which is substantially parallel to the plurality of ink channels, the second electrode is substantially U-shaped and extends along the first and second longitudinal edges and the first transverse edge, and the first electrode extends in an area defined by the U-shaped second electrode and in a direction parallel to the first and second longitudinal edges.

12. (Original) The print head of claim 5, further comprising:

a top body portion having a first plurality of ink channel grooves extending in a

longitudinal direction;

an intermediate body portion having an upper side and a lower side, a second plurality of ink channel grooves extending in a longitudinal direction along the upper side, the upper side of the intermediate body portion located adjacent the top body portion wherein the first and second plurality of ink channel grooves form the plurality of ink channels;

a main body portion located adjacent the lower side of the intermediate body portion; and

wherein the ink heater is located between the lower side of the intermediate body portion and the main body portion.

13. (Previously amended) The print head of claim 12, wherein the main body portion includes a recess and first and second grooves extending in a longitudinal direction from the recess, wherein the recess receives the thermistor material and the first and second grooves receive the first and second leads, respectively.

14. (Original) The print head of claim 13, wherein the thermistor material is secured to the intermediate body portion with thermally conductive adhesive, and an insulating air gap is formed in the recess between the thermistor material and the main body portion.

15. (Original) The print head of claim 14, further comprising a print head controller electrically coupled to the ink heater, wherein a voltage potential is applied across the first

and second leads.

16. (Original) An ink jet print head comprising:

a top body portion;

an intermediate body portion having an upper side and a lower side, a plurality of ink channels disposed in a common plane along the upper side, each of said channels having at least one orifice for projecting ink towards a substrate, the upper side of the intermediate body portion located adjacent the top body portion;

a main body portion located adjacent the lower side of the intermediate body portion; and

an ink heater made of a thermistor material, the ink heater having a substantially planar configuration and is located between the lower side of the intermediate body portion and the main body portion, and extends in a plane generally parallel to the plane of the ink channels and adjacent to the ink channels.

17. (Original) The print head of claim 16, wherein the ink heater is made of a thermistor material having a positive temperature coefficient.

18. (Original) The print head of claim 16, wherein the ink heater is made of a ceramic thermistor material.

19. (Previously amended) The print head of claim 17, wherein the thermistor material

includes a first side and a second side, and the ink heater includes a first electrode and a second electrode located on the first side of the thermistor material, wherein heat is generated on the first side of the thermistor material between the first and second electrodes.

20. (Original) The print head of claim 19, further comprising a first lead electrically coupled to the first electrode, and a second lead electrically coupled to the second electrode.

21. (Original) The print head of claim 19, wherein the plurality of ink channels include one or more channels which dissipate heat at a higher rate than other channels, and the first and second electrodes are located in an arrangement so that the thermistor material generates greater heat in a first area located adjacent the one or more channels than a second area adjacent the other channels.

22. (Previously amended) The print head of claim 19, wherein the ink heater include a first edge and a second edge, the first edge is located opposite from the second edge, the first and second edge extend in a direction which is substantially perpendicular to the plurality of ink channels, the first electrode extends along the first edge and the second electrode extends along the second edge, wherein the first and second electrodes are opposite from one another and substantially parallel.

23. (Previously amended) The print head of claim 21, wherein the plurality of ink channels include outside channels and inside channels, and the first and second electrodes

include a first end and a second end and a mid-portion, wherein the first and second ends are wider than the mid-portion, wherein greater heat is generated adjacent the outside channels than adjacent the inside channels.

24. (Previously amended) The print head of claim 21, wherein the plurality of ink channels include outside channels and inside channels, the first and second electrodes include a first end and a second end and a mid-portion, wherein the first and second ends are narrower than the mid-portion, wherein greater heat is generated adjacent the inside channels than adjacent the outside channels.

25. (Original) The print head of claim 19, wherein the ink heater include a first longitudinal edge, a second longitudinal edge, a first transverse edge and a second transverse edge, the first longitudinal edge is located opposite from the second longitudinal edge, the first and second longitudinal edges extend in a direction which is substantially perpendicular to the plurality of ink channels, the first transverse edge is located opposite from the second transverse edge, the first and second transverse edges extend in a direction which is substantially parallel to the plurality of ink channels, the first electrode is substantially U-shaped and extends along the first and second longitudinal edges and the first transverse edge, and the second electrode extends in an area defined by the U-shaped first electrode and in a direction parallel to the first and second longitudinal edges.

26. (Previously amended) The print head of claim 16, wherein the main body portion

includes a recess and first and second grooves extending in a longitudinal direction from the recess, wherein the recess receives the thermistor material and the first and second grooves receive the first and second leads, respectively.

27. (Original) The print head of claim 26, wherein the thermistor material is secured to the intermediate body portion with thermally conductive adhesive, and an insulating air gap is formed in the recess between the thermistor material and the main body portion.

28. (Original) The print head of claim 27, further comprising a circuit electrically coupled to the ink heater, wherein a voltage potential is applied across the first and second leads.

29. (Previously amended) A thermistor for heating ink in an ink jet print head, comprising:

a planar member made of thermistor material having a positive temperature coefficient; and

first and second electrodes extending on one side of said planar member.

30. (Previously amended) The thermistor of claim 29, further comprising a first edge and a second edge, the first edge is located opposite from the second edge, the first electrode extending along the first edge and the second electrode extends along the second edge, wherein the first and second electrodes are opposite from one another substantially parallel.

31. (Original) The thermistor of claim 29, wherein the first and second electrodes include means for thermally tuning the thermistor to the heat dissipation of the ink channels in the ink jet print head.

32. (Previously added) The thermistor of claim 29, wherein the first and second electrodes are formed in a pattern so as to thermally tune the thermistor.

33. (Previously added) A method of thermally tuning an ink heater for an ink jet print head comprising the steps of:

forming the ink heater using a thermistor material; and

attaching a plurality of electrodes to the ink heater.

34. (Previously added) The method of claim 33, wherein the plurality of electrodes are attached to the ink heater in a pattern based on the heat dissipation of the ink jet print head.

35. (Previously added) The method of claim 33, wherein the thermistor material has a positive temperature coefficient.

36. (Previously amended) A method of maintaining the ink in an ink jet print head at a uniform temperature wherein the ink jet print head has a plurality of ink channels generally

disposed in a common plane, the method comprising the step of using a planar ink heater generally parallel to said common plane and made of a thermistor material.

37. (Previously added) The method of claim 36 wherein the thermistor material has a positive temperature coefficient.

38. (Previously added) The print head of claim 13, wherein the thermistor material is secured to the intermediate body portion with thermally conductive adhesive.

39. (Previously added) The print head of claim 26, wherein the thermistor material is secured to the intermediate body portion with thermally conductive adhesive.